Oxford Textbook of Psoriatic Arthritis

Chapter 16

Plain Radiography

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7000 words maximum of text including tables and references

Abstract

Psoriatic Arthritis is a destructive inflammatory arthritis that can affect the peripheral and axial skeleton of patients with psoriasis. Plain radiography has formed an important part in defining psoriatic arthritis as a distinct clinical entity, from early work reporting on distinguishing features to more recent inclusion of osteoproliferation in the CASPAR classification criteria. Plain radiography is accessible, inexpensive and remains the standard measure of assessing damage in inflammatory arthritis. Originally considered a benign disease psoriatic arthritis is now recognised to be destructive and progressive, though not as aggressive as Rheumatoid Arthritis. Peripheral joint damage is characterised by erosions, joint space narrowing, osteoproliferation, osteolysis and ankylosis. Approximately twenty percent of patients have erosive disease at diagnosis progressing to approximately half of all patients by three years disease duration. In its most severe form, psoriatic arthritis mutilans, digits become shortened from gross bone resorption (osteolyisis) leading to severe functional impairment and disability. Spondyloarthritis may affect between 25-70% of patients with PsA. The radiographic features of Psoriatic Spondyloarthritis differ from Ankylosing Spondylitis, in that sacroiliitis is often asymmetrical and less severe, the cervical spine is frequently involved and syndesmophytes are asymmetrical and para-marginal. Overall radiographic features are less severe than Ankylosing Spondylitis. The natural history of both peripheral and axial radiographic damage in psoriatic arthritis in the modern era of early diagnosis, tight disease control and biologic drugs has yet to be established.

Introduction

The purpose of this chapter is to discuss the role of plain radiography in Psoriatic Arthritis (PsA). In an era of modern imaging techniques such as computed tomography, magnetic resonance imaging and musculoskeletal ultrasound plain radiography may seem obsolete. Plain radiography is however simple, accessible, inexpensive and as such remains the standard measure for the determination of disease progression and prognosis. We will briefly discuss the role plain radiography has had in establishing PsA as a distinct clinical entity, describe the radiographic features of peripheral and axial disease, the measurement techniques available and finally prognostic value and natural history.

Historical perspective & the role of plain radiography in defining Psoriatic arthritis

The association between psoriasis and arthritis was first made by Alibert in 1822 but PsA was only formally recognised by the American Rheumatology Association (ARA) as a distinct disease entity in 1964. The varying definitions of PsA and a suspicion it was simply concurrent Rheumatoid Arthritis and Psoriasis delayed progression in our understanding of the disease. Two factors in particular influenced the acceptance of PsA as a distinct disease, the development of the Rose-Waller agglutination test[1], to which most patients with PsA were found to be negative[2] and the development of modern radiology. With the routine use of plain radiographs in clinical practice it became apparent that there were clear distinguishing features between Rheumatoid Arthritis and PsA.

Case series of distinguishing radiographic features in PsA were reported in the 1950's [3, 4] but the first large prospective, study came from Wright in 1961 comparing the

radiographic features of 103 cases with PsA with cases of rheumatoid arthritis and gout.[5] Wright reported that radiographic damage amongst those with PsA was characterised by more frequent involvement of the distal interphalangeal and sacroiliac joints, terminal tuft resorption and was generally less severe than rheumatoid arthritis. With the advent of more robust classification criteria, terminology and modern epidemiology our understanding of radiographic damage in PsA has been refined.[6] Subsequent sections of this chapter will address the characteristics of radiographic damage in peripheral and axial PsA, modern measurement techniques and the natural history of radiographic damage.

Radiographic features of peripheral Psoriatic Arthritis

Soft tissue swelling is the first radiographic feature in early disease, either per-articular or affecting the whole digit in the presence of dactylitis. Periarticular osteopenia is recognised in PsA but felt to be less frequent than Rheumatoid Arthritis.[7] Subsequent features include erosions (articular or entheseal), joint space narrowing, osteolysis (bone resorption), osteoproliferation and ankylosis. The order in which these features occur has not been established. The pattern of joints affected radiographically follows the recognised clinical phenotypes of asymmetrical oligoathritis (in early disease), distal interphalangeal joint involvement, polyarthritis (in established disease) and less frequently monoarthritis and arthritis mutilans (Phenotypes are discussed in more detail in chapter X).[8] Joints typically affect a digital 'ray' rather than 'rows' of joints (as is typical in rheumatoid arthritis) and the distal interphalangeal joints are commonly affected, illustrated in figure 1. [9]

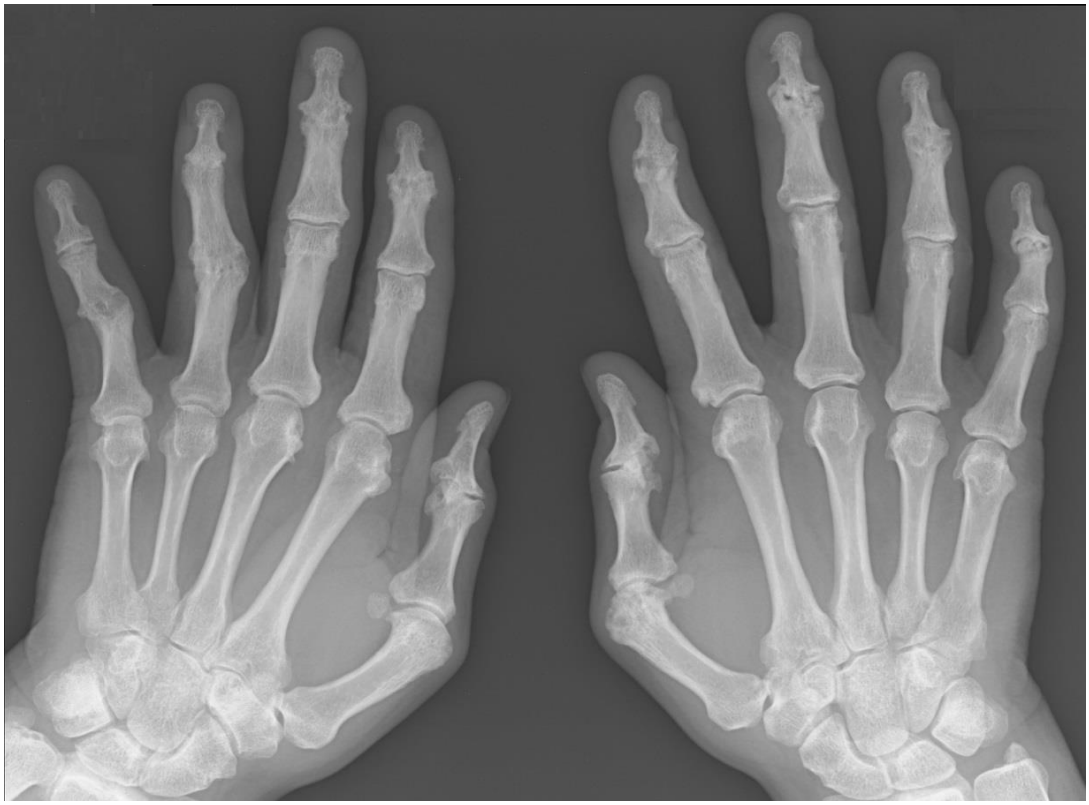

Figure 1- Hand Radiographs of a patient with psoriatic arthritis demonstrating asymmetric, erosive and ankylosing involvement of digital 'rays' rather than 'rows' of joints

Articular erosion

PsA is an erosive arthritis. [6, 8, 10, 11] One early study estimated the level of destruction to be equivalent to Rheumatoid Arthritis. [12] A large study from the Consortium of Rheumatology Researchers of North America (CORRONA) database of 2481 patients with PsA and 17,107 patients with RA showed a higher prevalence of erosions (47.4% vs 37.6%, p = 0.020) and deformity (25.2% vs 21.6%, p = 0.021) amongst patients with rheumatoid arthritis vs PsA.[13] The burden of erosive disease is however substantial, approximately half (47%) patients with early PsA have erosive disease within two years of diagnosis and up to two thirds have radiographic damage at their first visit to a PsA specialist.[10] [14] A longitudinal study of 139 patients with established PsA demonstrated progressive damage in established disease. Fifty-eight

percent of patients had radiographic damage at baseline (median 5 years disease duration) progressing to 78% at follow up (median 12 years disease duration).[15]

Differentiating erosions from PsA and Rheumatoid Arthritis or erosive osteoarthritis (particularly at the distal interphalangeal joints) can be particularly challenging as the morphology is similar. Erosions typically occur slightly away from the joint margin at the site of the joint capsule/ enthesis than at the joint margin as seen in Rheumatoid arthritis (Figure 2a).

Figure 2a-
Marginal erosions of the distal interphalangeal joints with juxtaarticular periostitis.

Figure 2b-
Close up view of the right 3rd distal interphalangeal joints demonstrating erosion and juxtaarticular periostitis.

The presence of osteoproliferation adjacent to the erosion is more likely to be related to PsA. Erosions at the distal interphalangeal joints can be difficult to distinguish from erosive osteoarthritis, especially as the two diseases often co-exist. Central erosions,

the absence of proliferation and presence of joint space narrowing can be useful indicators of osteoarthritis. Taylor, Porter and Helliwell defined the radiographic features of PsA in a study of one hundred and sixty four radiographs from sixty two patients.[6] PsA erosions can be defined as 'clearly defined marginal erosions with juxtaarticular periostitis or the absence of osteophytes, joint space narrowing or central erosions' (Figure 2b).[6]

Extra-articular erosions

Entheseal erosions may affect tendon insertions at the calcaneus, patellar, iliac crests, humeral tuberosity or greater trochanters.[16, 17] Entheseal ossification may occur at the same entheses in the form of irregular bony proliferation detectible on plain radiographs.

Osteolysis and Psoriatic Arthritis Mutilans

Osteolysis (bone resorption) can occur at the joint or tuft and is the radiographic characteristic of the most destructive phenotype of PsA- psoriatic arthritis mutilans.[16, 18-20] Psoriatic arthritis mutilans was originally described in 1913 by Marie *et al.*, who clinically described the telescoping of affected digits.[21] Psoriatic arthritis mutilans is currently defined radiographically by the presence of osteolysis affecting >50% of the articular surface on both sides of the joint, illustrated in figure 3.[22-24] Moll and Wright estimated an approximately 5% prevalence [25] which has been confirmed in subsequent studies. [26-28] The natural history of psoriatic arthritis mutilans has only recently been reported in a study of 39 patients over a median duration of ten years. Psoriatic arthritis mutilans typically presents as a monoarticular phenomenon initially with progressive destruction within the affected joint and progression to polyarticluar

involvement during follow up.[29] Patients with arthritis mutilans had earlier disease onset, worse physical function, greater nail and axial involvement than patients without mutilans.

Figure 3: Psoriatic Arthritis Mutilans.

An example of osteolysis and subsequent digital shortening in the hands and feet of the same patient. There is osteolysis and 'whittling' of the MPC joints resulting in the 'Pencil in Cup' pattern.

Osteolysis can also affect the phalange tufts resulting in a ‘whittled’ appearance. The combination of osteolysis on one side of a joint leading to ‘cup’ formation and ‘whittling’ to a ‘pencil’ form on the other side creates the ‘pencil in cup’ appearance recognised in PsA Figure 3.

Osteoproliferation (Juxtaarticular/ periosteal) and Ankylosis

Osteoproliferation is a characteristic feature in PsA and, although seen in other diseases such as peripheral spondyloarthritis, was found to be sufficiently specific to PsA to be included in the CLASsification of Psoriatic Arthritis (CASPAR) criteria.[30] As such the use of plain radiography remains an important component in the diagnosis of PsA. Osteoproliferation can occur both at the metaphasis and the diaphesis and is considered likely to be related to enthesitis. Irregular, spiculated

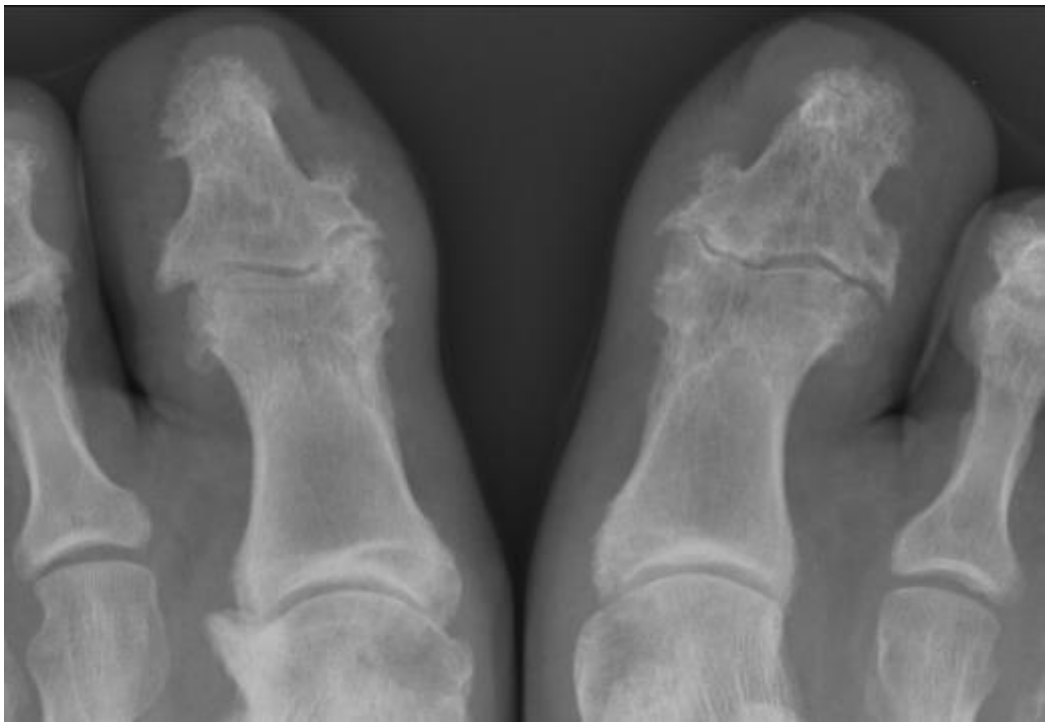

Figure 4:
Irregular, ‘spiculated’ osteoproliferation at the hallux interphalangeal joints.

osteoproliferation is seen at entheseal sites, illustrated in figure 4. Erosions can occur at the same site as osteoproliferation and this phenomenon has contributed to the leading hypothesis of disease aetiology in PsA of the synovio-entheseal complex.[31] Generalised thickening of the bony cortex can give rise the 'ivory phalanx' which is a rare phenomenon, most commonly see in the feet.

Bony ankyloses is defined as trabeculae crossing the joint space[6] and was recognised as a feature in many of the early radiographic reports in PsA Figure 5. [19, 20, 32] Ankylosis is most frequently seen at the interphalangeal joints[6] and has been seen to occur in the same ray as osteolysis in arthritis mutilans.[29]

Figure 5:

Ankylosis

Hands: Ankylosis of the left hand little and ring finger proximal interphalangeal joints and index, ring and middle distal interphalangeal joints.

Feet: Ankylosis of the right 3rd, 4th and 5th proximal interphalangeal joints with erosion and osteolysis in the same ray at the 3rd and 4th distal interphalangeal joints (also seen in the feet radiograph of Figure 3)

Radiographic features of Psoriatic Spondyloarthritis

History of Psoriatic Spondyloarthritis (PsSpA)

Axial disease in PsA was first described by Zellner in 1928 but it was not until 1955 when the phrase 'Psoriasis Spondylytica' was first used.[33] Wright reported sacroiliitis occurring more commonly in PsA than rheumatoid arthritis[5] and Dixon found a higher prevalence than healthy controls.[34] Kaplan reported a higher prevalence of facet joint sclerosis and anterior ligamental calcification of the cervical spine amongst patients with psoriasis, noting that the SIJ's and Lumbar spine were not always affected.[35] Jajic reported a case series in 1968 commenting that amongst 23 cases of PsA the majority had radiographic evidence of spondyloarthritis yet the mobility of the spine was maintained.[36]

Prevalence and associations of Psoriatic Spondyloarthritis (PsSpA)

Estimates of the prevalence of radiographic Psoriatic Spondyloarthritis (PsSpA) amongst patients with PsA range between 25-70%, depending upon cohorts and classification used. The burden of subclinical disease has yet to be fully determined. Studies in early PsA have shown ~20% of patients with PsA have radiographic evidence of SpA, in the absence of clinical symptoms.[37] Lambert and Moll first reported the association between HLAB27 and PsSpA in 1976 and the association of several HLA-B27 variants with PsSpA is now well established.[38, 39] Risk factors for radiographic axial disease in PsA are male sex, nail dystrophy, worse peripheral joint damage and elevated ESR.[39, 40]

Distribution and distinguishing features of Psoriatic Spondyloarthritis and Ankylosing Spondylitis [40-42]

In comparison with ankylosing spondylitis psoriatic spondyloarthritis has more frequent involvement of the cervical spine (figure 6) [43, 44], asymmetrical and less severe sacroiliitis (figure 7) [40], asymmetrical/ chunky and para-marginal syndesmophytes and paravertebral ossification (figure 8).[41, 42] Overall radiographic features are less severe in comparison ankylosing spondylitis, where sacroiliitis tends to be higher grade and accompanied by bilateral, marginal syndesmophytes.[45] Table 1 summarises the distinguishing features between AS and PsSpA.

Figure 6 -
Psoriatic Spondyloarthritis; Cervical spine involvement with flowing syndesmophytes similar to ankylosing spondylitis

Figure 7 -

Psoriatic Spondyloarthritis; Mild asymmetrical sacroileitis of the right sacroiliac joint

Figure 8-

Psoriatic Spondyloarthritis; 'Chunky' syndesmophytes and asymmetric sacroiliac involvement,

Table 1

Comparison of radiographic axial features of Ankylosing Spondylitis and Psoriatic Spondyloarthritis

Feature	**Anklylosing Spondylitis**	**Psoriatic Spondyloarthritis**
Sacroileitis	More severe Bilateral	Less severe Asymmetrical
Syndesmophytes	Progress from lumbar to cervical spine Symmetrical Marginal	Cervical spine more frequently involved Asymmetrical Para-marginal
Ossification	Ligamental	Para-vertebral

Measurement of Radiographic Outcome in Psoriatic arthritis

Measures of peripheral radiographic damage

There are several scoring methods that have been validated for use in PsA including the modified Sharp score [46, 47], the Sharp-van der Heijde modified method [47, 48], the modified Steinbroker[49] and the psoriatic arthritis Ratingen score.[50] With the exception of the Ratingen method these scoring systems were designed and validated for use in rheumatoid arthritis and subsequently modified for use in PsA.

The modified Steinbroker is a global method that assesses 42 joints of the hands and feet (considering the wrist as a single joint) for soft tissue swelling or osteopenia, erosion, erosion and joint space narrowing and total destruction (osteolysis or ankyloses) in a single global score for each joint.[49] The modified Steinbroker is feasible to learn, reliable and the quickest of the existing methods to perform but is less sensitive to change than the modified Sharp, Sharp-van der Heijde or Ratingen .[51] The Sharp-van der Heijde is a composite score that assesses 52 joints (including the small joints of the wrists) for erosion and joint space narrowing separately.[48] The Sharp-van der Heijde is reliable, readily learned and is the most sensitive to change of all the methods discussed but most time consuming to perform.[51] The psoriatic arthritis Ratingen method assesses for erosion or osteoproliferation characteristic for PsA at 40 joints in the hands and feet.[50] The method is reliable and sensitive to change and through the inclusion of osteoproliferation (the radiographic feature found to be sufficiently specific to PsA to warrant inclusion in the CASPAR classification criteria) arguably is the most specific to PsA.

A recent study has compared the sensitivity to change of each method including the smallest detectable differences.[51] These data confirmed the high sensitivity of the Sharp-van der Heijde method which has become the standard in randomised controlled trials. Radiographic change occurs slowly and most studies report small changes in each of these scores (Table 2). The minimally clinically important differences have not been established. Until such a study is undertaken the smallest detectible difference is regarded as relevant.

Table 2.

Sensitivity to change of the modified Steinbroker, modified Sharp, Sharp-van der Heijde or Ratingen methods in PsA.

Method	Mean Change	SD of change	SEM	SRM	SDD	SDC	SDD as % of total score	SDC as % of total score
Seinbroker	2.3	4.91	3.49	0.46	8.11	4.83	4.82	2.87
Psoriatic Ratingen	3.3	7.61	5.46	0.44	12.71	7.57	3.53	2.10
Destruction	1.6	3.46	2.51	0.45	5.83	3.48		
Proliferation	1.8	4.28	3.15	0.43	7.34	4.37		
Modified Sharp	5.5	7.15	5.06	0.77	11.77	7.01	2.42	1.44
Erosion	2.4	4.15	2.97	0.57	6.90	4.11		
JSN	3.3	5.10	3.64	0.64	8.47	5.05		
Sharp van der Heijde	5.2	6.53	4.66	0.79	10.83	6.45	2.05	1.22
Erosion	2.3	4.41	3.14	0.52	7.31	4.36		
JSN	3.0	4.36	3.14	0.68	7.29	4.35		

Modified Steinbroker method (STB), Sharp-van der Heijde modified method (VDH), Modified Sharp method (MSS), psoriatic arthritis Ratingen score (PARS), Joint space narrowing (JSN), Standard deviation (SD), Standard error of meas (SEM), Standardised response mean (SRM), Smallest detectable difference (SDD), Smallest detectable change (SDC).

Outcome measurement in Psoriatic Spondyloarthritis

As with peripheral arthritis, a number of scoring methods have been developed to measure axial damage in Psoriatic Spondyloarthritis. [52] Three scores, the Bath Ankylosing Spondylitis Radiology Index (BASRI), the modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS), and the Radiographic Ankylosing Spondylitis Spinal Score (RASSS) were originally developed for use in Ankylosing Spondylitis. A fourth method, the Psoriatic Arthritis Spondylitis Radiology Index (PASRI) was developed specifically to measure Psoriatic Spondyloartrhitis. These four methods have recently been compared in PsSpA and were all found to perform well.[52]

Natural history/ prognosis

Cohort studies have shown than PsA is destructive and progressive[10, 11] even in established disease.[15] One study used the modified Steinbrocker to assess the severity of a cohort of patients with PsA and RA and found the overall level of severity of peripheral arthritis to be comparable at a mean of seven years disease duration.[12] Approximately half patients will have erosive disease by two years disease duration.[14] Radiographic damage has been proven to be progressive in the majority even in established disease.[15, 29, 53] Polyarticular involvement, high ESR, HLAB27 positivity and high drug use predict radiographic progression.[11, 53-56]

Radiographic damage has historically been considered irreversible although a recent report of dramatic improvement seen in a patient treated with anti-tumour necrosis factor inhibitor for four years challenges this viewpoint.[57] Erosion scores measured using the van der Heijde method improved from 36 to 16 over four years. Improvements of this nature have been seen in Rheumatoid arthritis but are

considered rare.[58] Nevertheless it is likely that the natural history of radiographic damage in PsA will alter with increasing awareness of the disease, earlier diagnosis, tighter control of inflammatory disease and the increasing availability of novel biological agents proven to reduce radiographic damage.

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